N92-24123

An Architecture for the MSAT Mobile Data System

R.W. Kerr and B. Skerry
Telesat Mobile Inc.
P.O. Box 7800 Ottawa, Ontario
K1L 8E4, Canada
Phone: (613) 746-5601
Fax: (613) 746-2277

ABSTRACT

The MSAT MDS will offer a wide range of packet switched data services. The characteristics and requirements of the services are briefly examined. A proposed architecture to implement these services is presented along with its connectivity requirements. A description of the inbound and outbound channels is provided which are based upon the signalling for the circuit switched services. Also, the duties of the Network Management System are examined.

INTRODUCTION

The Mobile Data System (MDS) for MSAT will provide packet switched data to mobile users anywhere in North America. Due to the harsh nature of the land mobile environment, the system will have to be very robust in order to provide a virtual 'error-free' connection between the Mobile Earth Terminal (MET) and the Data Hub (DH). The Data Hub will be the central point at which all METs interconnect to other public and private data networks. Smaller Regional Data Hubs will provide service to METs in limited areas (one or two beams) and will possibly allow for a reduction in backhaul charges.

Central to the design philosophy behind the METs is the concept of an integrated voice and data terminal. All voice and data services will be available on the same MET, although the MDS will operate independently of the Mobile Telephone System (MTS) and the Mobile Radio System (MRS). However, it is anticipated that with the advent of ISDN in the Public Switched Telephone Network some of the services offered on the MDS could operate within the framework of the MTS.

Given the dual nature of the basic MET, it is foreseen that significant cost savings can be achieved by adopting as much as is feasible for the MDS from the signalling for the circuit switched services (MRS/MTS). Thus the same modulation, coding, interleaving etc. that is used for MRS/MTS signalling will be used as the basis for the packet switched data services [1]. As the MRS/MTS signalling packet sizes have not been optimized for data throughput, some changes will obviously have to be made.

Unlike some currently proposed mobile satellite systems [2,3] the MSAT MDS will not operate on the same inbound and outbound signalling channels used for the circuit switched services. This makes it possible to guarantee access to the system for MRS/MTS regardless of any congestion that would result from the MDS traffic. Also, this allows the data service to expand and change in a modular fashion independent of the MRS/MTS. Different service providers can decide to offer their own packet or circuit switched services autonomously.

Service Offerings

The MDS will provide packet switched data services to both integrated voice/data METs as well as dedicated data terminals. Many of these services are currently being offered [4], but the MSAT MDS will allow for faster, cheaper, and more flexible service. Some of these services are described below, although the list is not exhaustive.

Vehicle Location. Automatic Vehicle Location (AVL) will allow a central dispatcher to monitor the position of a fleet of vehicles, with periodic updates. This implies some sort of navigation device on the vehicle, such as Loran-C or GPS. This can be coupled with navigation services to allow for optimum routing of a vehicle.

Two-way general messaging. Short messages can be sent between a MET and public or private data networks. An electronic mail box would be a value added service to store messages if a MET is unavailable.

File transfer. This would provide for the MET to exchange relatively long files with the DH. There would be a tradeoff as to whether a file should go as packets on the MDS or demand a circuit via the MRS/MTS.

Interactive data. In order to allow for interactive data sessions, the MDS will have the capability of guaranteeing a specified response time. This could be done either on a priority basis or by assigning a TDMA slot for the MET.

Monitoring and control. Supervisory Control and Data Acquisition (SCADA) will allow for METs to monitor and control METs on a real-time basis.

Virtual circuits. A MET will be able to request a virtual circuit of variable throughput in order to establish a 'virtual circuit'. This would give a user a TDMA slot into which they can put whatever data they wish. From the DH to a MET, the user can be allocated one of the TDM slots on a demand-assigned basis.

ARCHITECTURE

The main Data Hub will be the central point in a double star network configuration. It will manage communications between a large number of MSAT data terminals and various public or private data networks. In the overall MSAT network, the Data Hub will communicate with a Group Controller (GC) to request channels for the operation of the packet data network (see Figure 1). The GC is responsible for managing power and bandwidth resources. Note that this architecture has many similarities with existing VSAT networks [5].

It is possible as that traffic in certain areas or beams will require the addition of a regional data hub. A regional DH may only need to operate in one or two beams and would handle a subset of the MDS customers (see Figure 2). The main DH will communicate in all beams and can assign METs to a regional data hub. Once assigned to the regional DH, that DH will control a MET.

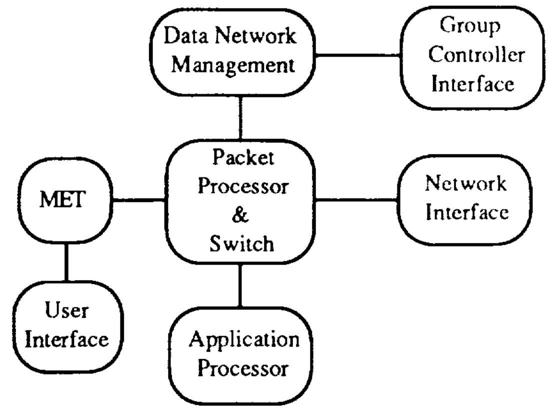

Figure 1. Data Hub Architecture

Network operation will be managed on the assigned channels by the Network Management System (NMS) at the Data Hub. The NMS carries out all of the functions which are required for the efficient operation of the network. A description of the NMS capabilities are discussed below. This structure reduces the GC processing load and the need for combined packet data and signalling channels for the GC, as the DH has the responsibility of managing the data channel implementation and user assignments.

The NMS has direct control over the Packet Processor, which is responsible for the operation of the communication links and all of the operations required to convert satellite packets to a form of data usable by the destination network and routing it to that network (and vice versa). The protocols used on the other networks are well defined standards. In the initial implementation, the protocol that will be used will be X.25. Other protocols may be implemented at a later date, depending on customer demand.

On the satellite side of the Packet Processor, the communication link protocols between the MET and the DH can not be well established protocols. This is because the propagation environment for Mobile Satellite communications can result in bursts of errors . The proposed protocols for the MDS satellite communication links are described in a later section.

The MSAT MET will convert the data for the User terminal from the satellite protocol to a standard protocol to allow for an asynchronous connection between the MSAT MET and User terminal. This terminal could take the form of a hand-held keyboard/display, or possibly a personal computer.

The MDS will be able to offer a wide variety of additional features through the addition of an application processor. This processor handles value added services, which enhance the service seen by the customer and are not a function of a communications network. For example, these features could include a mailbox, a paging service, or broadcast services where a message is periodically repeated.

Channel Descriptions

As indicated previously the MDS is based upon the signalling for the MRS/MTS [1] which in turn draws heavily upon other proposed systems [2,3,6]. However, the MDS has been designed to allow greater data throughput and more flexibility while at the same time trying to reduce the complexity of both the METs and the network infrastructure.

Signalling unit structure. The basic signalling unit (SU) structure is 96 bits long. Note that although the term signalling unit is used, the packet may contain data and/or signalling (but of course only for the MDS). The 96 bit SU includes a CCITT recommended 16 bit Cyclic Redundancy Check (CRC) for error checking.

In order to gain greater data throughput, SUs can be 'chained' together either in the same frame or in subsequent frames. This allows an initial SU (ISU) to be followed by one or more subsequent SUs (SSU) as in other systems [6]. Thus the addressing and other overhead needs to be sent only in the ISU.

Modulation and coding. The proposed initial form of modulation to be used on the MDS is Aviation Binary Phase Shift Keying (A-BPSK) at a transmission rate of 2400 sps (the same as the MRS/MTS signalling). Rate 1/2 coding (k=7) will be used which gives an information rate of 1200 bps.

Future expansion of the MDS could lead to the inclusion of trellis coded modulation (TCM) at 4800 bps [7]. This may be fairly easy to implement because TCM may be used as one of the modulations for the voice channel. Others could be added as well. Thus a fully developed MDS could have a wide range of modulation and coding techniques as in the aeronautical system [3]. This would provide service to a variety of METs with different characteristics and under various propagation environments.

DH-P channel. This is the outbound TDM channel from the Data Hub to the METs. Its frame structure is very similar to the signalling outbound channel for the GC (see figure 3). Data packets may be grouped in 3 or 4 SUs (ISU and 2 or 3 SSUs) in one frame to increase the data throughput to a MET. The DH configuration will be broadcast periodically to ensure every has the current parameters and channel assignments.

MET-R channel. This inbound random access channel will be similar to the signalling access channels. The difference is that short messages will be allowed on these channels (see Figure 4). Messages of up to 3 packets will be able to be sent. Initial SU with the address and header and up to two Subsequent SUs which contain a reference to the ISU, data and CRC, hence increasing the amount of data that can be sent in a packet.

The MET-R channel will use Sloppy Slotted Aloha [8] in order to minimize the guard times. Sloppy Slotted Aloha is a form of Slotted Aloha in which METs are allowed to 'spill over' into adjacent slots on their first access, but will have their timing corrected for subsequent accesses. The retransmission interval of the MET-R channel will vary dynamically in accordance with the traffic.

MET-T channel. The inbound TDMA channel will have very short guard times like the MET-R channel because any MET using the MET-T channel is assumed to have its timing corrected. It may have larger packets that MET-R channel, and/or the capability to assign multiple adjacent slots in every frame to increase the data throughput.

Network Management System. One of the duties of the NMS is scheduling long-term accesses on MET-T channels. A few of the expected applications require allocation of capacity for periodic reporting. The reservation may be needed in one of two ways, either by a customer selected reporting interval or at a specific time. For a given interval, the NMS assigns the MET to a slot that is a given time period from the first transmission where the MET requested the service. The specific time reservation the NMS assigns capacity within a minute of the customer selected time. The NMS re-assigns METs' accesses when it is necessary.

It is expected that short term assignments to the MET-T channel, such as reservations for multi-packet transmissions will be sent on a separate MET-T channel to avoid conflicts between long and short term reservations.

The NMS also exercises control on all of the METs accessing the DH. This is required to prevent malfunctioning METs from interfering with other communications, by either corrective actions, such as adjustments to the MET's frequency or timing, or a complete shutdown of the MET. Control of the MET is also a requirement of the network to accommodate pre-emption requirements for AMSS.

SUMMARY

The Mobile Data System on MSAT will provide for a wide variety of services for users across North America. By adapting as much as possible from the circuit switched services, the cost of both the network infrastructure and the METs can be significantly reduced. At the same time, by offering the MDS on separate channels from MRS and MTS signalling, independence of the services is assured, which enhances the system's flexibility and modularity.

The concept of a regional Data Hub offers further possibilities for gradual system expansion to meet specific market needs. By offering inter-connectivity with public and private data networks as well as many value added services, the MDS will be able to provide a comprehensive set of data services.

REFERENCES

[1] "A Network Control and Signalling System for the North American MSS", CCIR SG8 Final Meeting, November 1989.

[2] Mobilesat System Description, Aussat Mobilesat, September 1989.

[3] Aviation Satellite Communications (SatCom) System, Project Paper 741, AEEC, March 1988.

[4] M. Shariatmadar, K. Gordon, B. Skerry, H. El-Damhougy, D. Bossler, "System Architecture for the Canadian Interim Mobile Satellite System", Proceedings of the Mobile Satellite Conference, pp 163-169, May 1988.

[5] J. Stratigos, M. Rakesh, "Packet Switch Architectures and User Protocol Interfaces for VSAT Networks", IEEE Communications Magazine, Vol. 26, No.7, pp 39-47, July 1988.

[6] Standard-M System Definition Manual, INMARSAT, September 1989.

[7] R. Kerr, P.J. McLane, "Coherent Detection of Interleaved Trellis Encoded CPFSK on Shadowed Mobile Satellite Channels", IEEE GlobeCom '89, November 1989.

[8] S. Crozier, "Sloppy-Slotted Aloha", Second International Mobile Satellite Conference, published in these proceedings, June 1990.

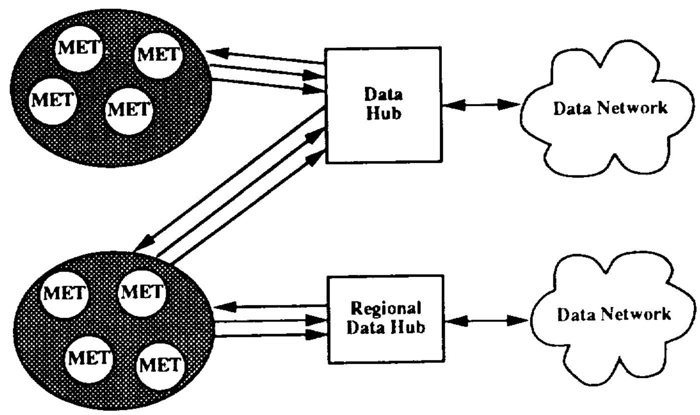

Figure 2. Network Topology

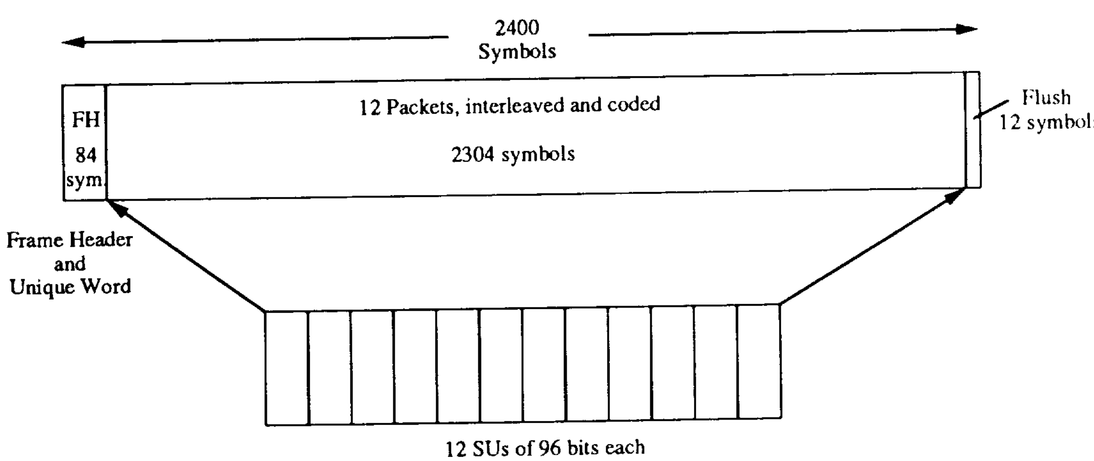

Figure 3. DH-P Channel Format

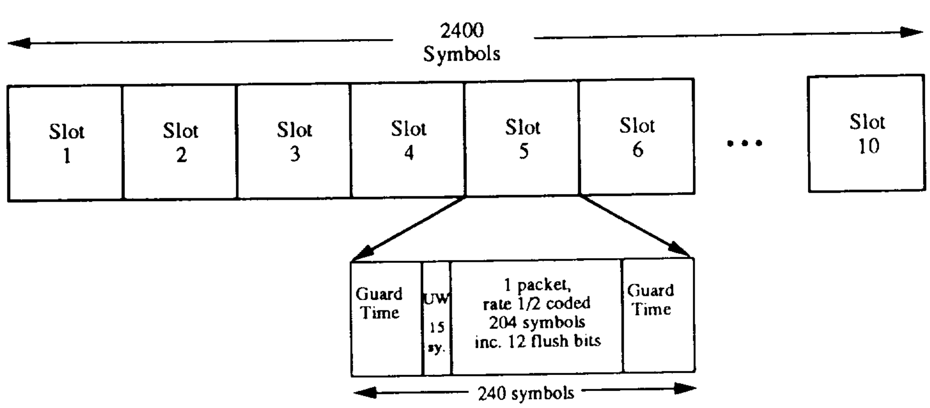

Figure 4. MET-R Channel Burst Format